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ANALYTICAL NOTES ON THE FLORA OF SOUTH AUSTRALIA

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Abstract

The taxa in the recently published 'Flora of South Australia' are analysed quantitatively in different ways and compared with those found in Victoria, Australia, as well as the world. A high percentage of naturalised taxa and low number of endemics are characteristic of the S. Australian flora which shares many taxa with surrounding territories. The largest families and genera are tabulated. An attempt is also made to assess the advances in knowledge made during the past 60 years in order to establish the present level of understanding of the S. Australian flora.

Black (1922-29) recognised about 2400 species in the first edition of the 'Flora of South Australia'. He included 2982 species in the second edition (1943-57). These additional 582 species, 19.5% of the flora, represent an average addition of nineteen species per year during approximately 30 years. Eichler (1965) added more species in his 'Supplement', but this publication is better known for its corrections and changes to previously accepted names. Further additions were made in part I of a third edition by Jessop (1978), but this edition was never completed.

Nearly thirty years after the second edition a complete fourth edition has been published. There are now 3639 species described, adding 657 species, 18.1% of the flora, or an average increase of 22 species per year. The rate of increase of knowledge of the flora has been, if measured by the number of species added, more or less constant during the past 60 years. Churchill & de Corona (1972) reported an average annual increase of 15 species in the Victorian flora for the period of 1931-72 and Ross (1976) found that it continued at the same rate.

A comparison of the South Australian flora with that of Victoria is instructive since Ross (1976) published a detailed evaluation of the latter although now slightly outdated. Any comparisons can only be taken as indicative because different approaches were used in the delimitation of families and genera and the number of species would have presumably increased at an average annual rate of 15 species since the beginning of 1976. Adjustments made for surface area, South Australia (380,070 miles^2) is more than four times the size of Victoria (87,884 miles^2), would not give a totally reliable comparison as only small southern areas of South Australia are climatically comparable with Victoria. Large parts of South Australia belong to a relatively poor flora of semi-arid central Australia (Maslin & Hopper 1982), and because of the absence of natural boundaries South Australia shares taxa with all adjoining territories. The more humid climate of Victoria supports approximately double the number of Pteridophyta than S. Australia (Table 1) at genus and species level. The incompletely published 'Flora of south-eastern Queensland' by Stanley & Ross (1983) with its estimated 3600 species for a surface area of about 71,255 miles^2, may become a very closely comparable floristic region with that of Victoria.

The 'Flora of South Australia' (1986) describes 159 families, 1016 genera and 3639 species compared with Willis (1970-72), the basis of Ross (1976), who recognised 178 families, 918 genera and 3322 species for Victoria (see Table 1). Forbes et al. (1984) updated information on the Victorian flora and although there are references to taxa accepted by Willis, they do not distinguish between name changes and the less common addition of new species.

Most comparisons are made here on the basis of percentage. In the South Australian flora there are 2671 indigenous species, or 73.4% compared with 77.6% in Victoria. The

		Families				Genera				Species					
		Total		Naturalised		Total		Naturalised		Total		Indigenous		Naturalised	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%
Pteridophyta	SA	18	11.4	0	0	31	3.1	0	0	59	1.7	55	1.5	4	0.1
	VIC	24	13.5	0	0	47	5.2	0	0	112	3.4	111	3.4	1	0.1
Gymnospermae	SA	2	1.3	1	0.7	2	0.2	1	0.1	10	0.3	5	0.1	5	0.2
	VIC	3	1.7	1	0.6	3	0.4	1	0.1	9	0.3	6	0.2	3	0.1
Dicotyledoneae	SA	109	68.6	25	15.8	723	71.3	291	28.7	2703	74.3	1978	54.4	725	20.0
	VIC	115	64.6	14	7.9	626	68.2	201	21.9	2318	69.8	1256	52.9	562	17.0
Monocotyledoneae	SA	30	18.9	5	3.2	260	25.7	85	8.3	867	23.9	633	17.4	234	6.5
	VIC	36	20.3	5	2.8	242	26.4	66	7.2	883	26.6	702	21.1	181	5.5
Total	SA	159		31	19.7	1016		376	37.0	3639		2671	73.4	968	26.8
	VIC	178		20	11.3	918		268	29.2	3322		2575	77.6	747	22.5

Table 1. Proportional representation of the total number of families, genera and species and their naturalised component in the South Australian compared with the Victorian flora (Ross 1976). (Percentages are calculated of the total of each taxon in its respective flora.)

Dicotyledoneae are at all levels between 3 and 8% (Table 1) better represented in South Australia than in Victoria while the Monocotyledoneae are marginally better represented in Victoria. The percentage naturalised species in the Dicotyledoneae of both States is about three times larger than in the Monocotyledoneae, and in both groups the percentage is larger in South Australia than in Victoria.

Table 2 provides a comparison of the South Australian and Victorian floras, especially their indigenous components, with the flora of the whole of Australia including Tasmania. The genera are predictably represented by a higher percentage being a higher taxonomic grouping and thus more likely to have a wider distribution. The percentage representation of the total of the genera in the Monocotyledoneae and Dicotyledoneae is almost twice that of the species for both States. The percentage representation of all categories of Dicotyledoneae and the genera of Monocotyledoneae are higher for South Australia (cf. Table 1). The percentage of the total species of Monocotyledoneae is about equal for both States and that of the indigenous species is higher for Victoria. It must also be noted that once the Monocotyledoneae of both States are expressed in terms of the flora of Australia they have a marginally higher representation throughout whereas their relative representation is about one-third that of the Dicotyledoneae (cf. Table 1). Similarly the percentage of the total genera and species of the Pteridophyta are raised into the range of those for the Angiospermae, while figures for the Gymnospermae remain very low for both States.

Tables 3 and 4 present some of the largest angiosperm families in South Australia shown in relation to figures for Victoria, Australia and the whole world. The floras of Victoria, Australia and the world would each have a somewhat different descending order of families and additional families would need to be inserted where they are not well represented in South Australia. In Table 3 the families are arranged in order of decreasing number of genera, while in Table 4 they are arranged in order of similar numbers of species. Beadle (1981) published a list of all Australian families with their number of genera, species and their distribution together with similar data for the world. In Figs 2.9, 2.10 he illustrated diagramatically the proportions of the Australian flora in the world's largest families in regard to their genera and species. The characteristics of the flora of South Australia approach the structure of his 'the flora of the arid zone'. The figures for the number of genera and species in the world's larger families vary greatly according to the source as shown in the last two columns of Tables 3 and 4 and should consequently be treated as estimates.

The largely indigenous families often have very large genera so that they rank much higher in Table 4. These include the Myrtaceae, Goodeniaceae and Myoporaceae, while the Epacridaceae is relatively small in South Australia in contrast to Australia as a whole. The large families account for 71.2% of the genera and 77.6% of the species in South Australia and similar high percentages were reported for Victoria (Ross 1976).

In contrast, the largest genera each with 25 or more species, account for only a small part (17.6%) of the South Australian species (cf. Table 5). All of them have a low number of naturalised species except for *Senecio* and *Solanum*. The total of the naturalised species amount to 3.5% as compared with 26.8% (Table 2) of the flora of South Australia. Their percentage endemism is slightly higher (10.2%) than the 6.4% for the whole State. All genera have at least one species endemic to South Australia.

Discussion

Ross (1976) makes special mention of the high incidence of naturalised taxa in Victoria and they are here similarly delimited in that families and genera are restricted to those with all their species being of foreign origin. These species are usually introduced from outside Australia but in about fifteen cases in the South Australian flora, e.g. four in *Acacia*, they are interstate introductions. In South Australia there is a particularly large percentage of naturalised

	Genera									Species									
	South Australia				Victoria				Australia	South Australia				Victoria				Australia
	Total		Indigenous		Total		Indigenous			Total		Indigenous		Total		Indigenous		
	No	%	No	%	No	%	No	%	No	No	%	No	%	No	%	No	%	No
Pteridophyta	31	26.1	31	26.1	47	39.5	47	39.5	119[1]	59	14.6	55	13.6	112	27.7	111	27.4	405[1]
Gymnospermae	2	11.8	1	5.9	3	17.7	2	11.8	17	10	14.3	5	7.2	9	12.9	6	8.6	70
Dicotyledoneae	723	41.7	442	25.5	626	36.1	425	24.5	1735	2703	22.4	1978	16.4	2318	19.2	1756	14.5	12085
Monocotyledoneae	260	42.4	180	29.3	242	39.5	176	28.7	614	867	24.2	633	17.7	883	24.7	702	19.6	3585
Total	1016	41.1	654	26.4	918	37.1	650	26.3	2475	3639	22.6	2671	16.6	3322	20.6	2475	15.3	16140

Table 2. Proportional representation of the total number of genera and species and their indigenous component in the South Australian compared with the Victorian flora (Ross 1976). (Percentages are calculated of the total of each category in the Australian flora (Morley & Toelken 1983; R.J. Chinnock[1] oral comm.).

	South Australia				Victoria		Australia	World[1]	World[2]
	Number of Genera	% of Total[4]	%[3] Indigenous	%[3] Naturalised	Number of Genera	% of Total[4]	Number of Genera	Number of Genera	Number of Genera
Compositae	137	13.5	52.6	47.5	105	11.4	201	900	1100
Gramineae	119	12.7	59.7	40.3	106	11.6	217	620	670
Papilionoideae	61	6.0	73.8	26.2	42	4.6	136	400	500
Cruciferae	43	4.2	37.2	62.8	39	4.3	53	375	375
Chenopodiaceae	27	2.7	88.9	11.1	18	1.9	31	102	100
Liliaceae	27	2.7	55.5	44.5	23	2.5	53	250	219
Umbelliferae	26	2.6	50	50	24	2.6	36	275	300
Orchidaceae	22	2.2	100	—	25	2.7	90	735	600
Iridaceae	22	2.2	9.1	90.9	17	1.9	29	60	70
Labiatae	20	2.0	45	55	19	2.1	38	180	200
Caryophyllaceae	20	2.0	25	75	20	2.2	25	70	80
Cyperaceae	19	1.9	100	—	21	2.3	47	90	90
Scrophulariaceae	19	1.9	52.6	47.4	19	2.1	44	220	250
Malvaceae	18	1.8	61.1	38.9	10	1.1	24	75	85
Aizoaceae	17	1.7	52.9	47.1	10	1.1	19	130	140
Euphorbiaceae	15	1.5	86.7	13.3	13	1.4	53	300	300
Boraginaceae	14	1.4	57.2	42.8	12	1.3	23	100	100
Solanaceae	14	1.4	16.3	83.3	9	1.0	24	90	84
Rosaceae	12	1.2	81.8	18.2	12	1.3	24	100	122
Myrtaceae	11	1.1	80	20	13	1.4	70	100	147
Rubiaceae	10	1.0	100	—	8	0.8	42	500	500
Rutaceae	9	0.9	100	—	10	1.1	41	150	150
Convolvulaceae	9	0.9	100	—	6	0.7	18	55	55
Epacridaceae	9	0.9	100	—	15	1.6	28	30	31
Goodeniaceae	8	0.8	100	—	6	0.7	16	14	17
Proteaceae	8	0.8	100	—	10	1.1	45	62	75
Amaranthaceae	7	0.7	71.4	28.6	3	0.5	14	65	65
Asclepiadaceae	7	0.7	57.1	42.9	5	0.6	19	130	130
Restionaceae	7	0.7	100	—	6	0.7	20	28	28
	723	71.2[4]	43.5[4]	27.7[4]	622	67.8[4]	1480	6206	6583

Table 3. The 29 largest families (including subfam. Papilionoideae) represented by 7 or more genera listed in order of decreasing number of genera and compared with similar figures for Victoria (Ross 1976) and Australia (Morley & Toelken 1983) as well as the world (Airy Shaw 1973[1]; Morley & Toelken 1983[2]). (Percentages are calculated of the number of genera in the family[3], or the total of each category in the respective flora[4]).

	South Australia					Victoria		Australia	World[1]	World[2]
	Number of species	%[4]	%[3] Endemic	%[3] Indigenous	%[3] Naturalised	Number of species	% of Total[4]	Number of species	Number of species	Number of species
Compositae	433	11.9	5.1	70.7	29.3	361	10.9	970	13000	25000
Gramineae	374	10.3	3.2	63.4	36.6	323	9.7	1225	10000	9000
Papilionoideae	206	5.7	6.8	67.0	33.0	202	6.1	1100	9000	12000
Chenopodiaceae	198	5.5	5.1	95.5	4.5	101	30	300	1400	1500
Orchidaceae	128	3.5	7.0	100	—	175	5.3	100	17000	30000
Myrtaceae	126	3.5	15.9	97.6	2.4	138	4.2	1280	3000	3000
Cyperaceae	122	3.4	3.3	91.0	9.0	168	5.1	650	4000	4000
Mimosoideae	110	3.0	15.5	95.5	4.5	94	2.9	700	2000	3000
Cruciferae	107	2.9	2.8	53.3	46.7	80	2.4	153	3200	3200
Liliaceae	76	2.1	7.9	65.8	34.2	49	1.5	188	3700	3500
Goodeniaceae	71	2.0	12.7	100	—	42	1.2	380	300	410
Solanaceae	69	1.9	7.3	60.9	39.1	48	1.4	186	2000	2000
Umbelliferae	56	1.5	1.8	69.7	30.4	57	1.7	167	2850	3000
Scrophulariaceae	53	1.5	9.4	60.4	39.6	51	1.5	165	3000	3-5000
Labiatae	52	1.4	15.4	57.7	42.3	51	1.5	250	3500	3000
Amaranthaceae	51	1.4	3.9	74.5	25.5	21	0.7	131	850	900
Euphorbiaceae	51	1.4	7.9	72.6	27.5	33	1.0	215	5000	5000
Myoporaceae	50	1.4	10.0	100	—	18	0.5	198	90	215
Malvaceae	49	1.4	2.0	73.5	26.5	27	0.8	160	1000	2000
Proteaceae	48	1.3	22.9	93.7	6.3	66	2.0	900	1050	1500
Caryophyllaceae	46	1.3	—	26.1	73.9	48	1.4	75	1750	2000
Iridaceae	44	1.2	—	6.8	93.2	29	0.9	74	800	1800
Aizoaceae	37	1.0	—	62.2	37.8	17	0.5	60	1200	2300
Boraginaceae	36	1.0	11.1	52.8	47.2	29	0.9	89	2000	2400
Polygonaceae	35	1.0	5.7	51.4	48.5	31	0.9	47	800	750
Rosaceae	34	0.9	—	20.6	79.4	32	1.0	65	2000	3370
Rutaceae	34	0.9	20.6	100	—	49	1.5	320	900	1800
Rubiaceae	33	0.9	3.0	78.8	21.2	39	1.2	203	6000	7000
Convolvulaceae	32	0.9	3.1	78.1	21.8	16	0.5	100	1650	1650
Haloragaceae	31	0.9	3.2	100	—	23	0.7	90	120	120
Epacridaceae	30	0.8	13.3	100	—	60	1.8	335	400	426
Total	2822	77.6[4]	4.7[4]	57.6[4]	20.0[4]	2478	74.7[4]	10876	103560	140841

Table 4. The 31 largest families (including subfams Mimosoideae and Papilionoideae) with 30 or more species in South Australia are listed in decreasing order of species and compared with figures for Victoria (Ross 1976) and Australia (Morley & Toelken 1983) as well as the world (Airy Shaw 1973[1]; Morley & Toelken 1983[2]). (Percentages are calculated of the number of species in the families[3], or the total of each category in the respective flora[4]).

	South Australia			Victoria	Australia
Genera	Total number of species in South Australia	Number of Endemic in South Australia	Number of Naturalised species in South Australia	Total	Total
Acacia	107	17	4	93	660
Eucalyptus s.l.	63	9	—	79	470
Eremophila	44	4	—	13	180
Atriplex	42	4	1	24	60[2]
Stipa	40	4	—	23	61
Goodenia	39	6	—	22	170
Maireana	39	2	—	19	57[2]
Sclerolaena	35	2	—	16[1]	62[2]
Solanum	31	1	11	25	125
Brachycome	30	6	—	34	52
Olearia	30	2	—	37	80
Swainsona	29	3	—	14	52
Pterostylis	29	2	—	39	65
Senecio	29	1	7	27	36
Helipterum	27	1	—	15	60
Ptilotus	25	1	—	9[1]	79
Total	639 17.6%[2]	65 10.2%[3]	23 3.5%[3]	489 14.7%[2]	2269 14.1%[2]

Table 5. The 16 largest genera with 25 or more species in South Australia listed in decreasing order and compared with respective figures for Victoria (Ross 1976) and Australia (Morley & Toelken 1983; P.G. Wilson 1984[1]). (Percentages are calculated of the total number of species in the respective flora[2], the sum of species enumerated[3]).

taxa in the Angiospermae (Table 1) and this cannot be explained wholly by differences in the interpretation and definition of naturalised taxa, adventives and casuals. It might reflect the presence of several botanists especially interested in aliens. There are 31 families, or 19.7%, 376 genera, or 37.0%, and 968 species, or 26.8% of the flora, naturalised in South Australia. Green (1985) reported only 838 naturalised species in a flora of 7963 species of Western Australia.

All 31 families confined to naturalised aliens have only 1-5 genera (Table 6) and 371 genera of these 376 naturalised have 1-5 species. Of the 122 (76.7% of the total) families with only 1-5 genera 91 (71.1%) are indigenous families; of 857 (84.4% of the total) genera, 486 (56.7%) comprise 1-5 species. In order to further illustrate the extent of naturalised taxa in the South Australian flora, the number of families with at least half of their genera having half or more of their species naturalised raised the above figure from 31 families to 53 (Table 6) among those with 1-5 genera.

Table 3 and 4 show that families vary greatly in the ratio of naturalised and indigenous taxa and generalisations can rarely be made. For instance, the Caryophyllaceae and Cruciferae are well known for their high content of naturalised weeds, but they are unexpectedly surpassed in S. Australia by the Iridaceae, a family rarely found in this category in many floras. Similarly, the Chenopodiaceae are usually classed with the above two weedy families, yet in S.Australia it has a very low content of naturalised genera and species. Other families with a high number of species indigenous to Australia such as the Rutaceae and Proteaceae have few or no naturalised species in South Australia in spite of many species being widely cultivated.

Some 6 genera (0.6% of the flora) are endemic to South Australia viz. *Achnophora* (1 sp.), *Basedowia* (1 sp.), *Carinavalva* (1 sp.), *Embadium* (3 spp.), *Grammosolen* (2 spp.) and *Pseudanthus* (1 sp.), and 234 species are endemic consisting of 201 Dicotyledoneae and 33

No. of genera in family	No. of families	% of Total	No. of families with only naturalised genera	% of Total	No. of families with ½ or more genera and species naturalised	% of Total
1	66	41.5	25	15.7	30	18.9
2	23	14.5	3	1.9	5	3.1
3	15	9.4	2	1.3	9	5.7
4	10	6.3	—	—	6	3.8
5	8	5.0	1	0.6	3	1.9
Total	122	76.7	31	19.5	53	33.4

Table 6. Proportional representation of families with 1-5 genera as well as the proportional naturalised component expressed in two different ways.

Monocotyledoneae. The endemic species represent 6.4% of the species in the State and 1.5% of the total Australian flora. Unfortunately no such information is available for Victoria. South Australia could be grouped with poorer continental floras having a low percentage of endemism and is comparable to the British Isles (1.2% endemism), but not Europe as defined by 'Flora Europaea' which includes the Mediterranean region (33% endemism) Webb (1978). This low endemism in S. Australia is significant as Australia was estimated to have 85% endemism (Specht et al. 1974) comparing well with New Zealand (81.1%), or Hawaii (92.3%) (Raven & Axelrod 1978). In contrast, the endemism of southern Western Australia is estimated at 68% (Tilman et al. 1983). There are centres of higher endemism in parts of South Australia, especially Kangaroo Island, but details are not at present available.

The figures for number of species in Australia are based on Morley & Toelken (1983), which are considered conservative, yet the 15735 species referred to there, or 16140 vascular plants, exceed the upper limit of the estimates of Specht et al. (1974) and Beadle (1981) of 13-15000. Both Specht and Beadle based their figures on Burbidge (1963). Black (1943, p. 9) reported that "no less than 1400 genera and 8163 species were described" in Bentham's 'Flora Australiensis' when completed in 1878. In little more than a century the numbers of recognised genera and species have almost doubled to 2475 and 16140 respectively. The comment by Ride (1978, p. 79) 'it is currently believed that the Australian flora comprises about 25000 species of vascular plants', an assumption probably based on a few genera, shows that the Australian flora is far from being taxonomically described. Other evidence on how thoroughly the Australian vascular flora is known is shown in the abscence of any decrease in the average number of new species recorded per year in both South Australia and Victoria. These additions consist of species new to science, species previously only known from other States and newly naturalised species. Since a similar constant increase of the number of naturalised species has been found (Kloot, oral comm.), the resultant number of new species and new records of species must also be constant. The new 'Flora of South Australia' is a great improvement on the existing literature, but at the same time new species and a more adequate knowledge of existing species distribution, biology and environmental requirements still need to be acquired.

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